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ABSTRACT

The interconnection between personal computers and other personal, mini, or mainframe computer systems is discussed. The following topics relevant to college personnel are addressed: hardware techniques for tying computers together, advantages and disadvantages of available software, the prospects for sophisticated micro/mainframe links with major software systems, strategies for data sharing, the role of the information center, and the products that have been used at McGill University in Quebec, Canada. Ways to exchange information stored on a personal computer include paper (e.g., a spreadsheet), and diskettes. One disadvantage of paper is the need to reenter data already in machine readable form, while disadvantages of diskettes include handling problems and media incompatibility. Additional ways to exchange information are covered: use of telephone wires, major networks or local area networks, and telecommunication (synchronous, bisynchronous, or asynchronous). For causual telecommunication, public telephone lines or twisted pair wiring may be used; however, for more dedicated use, a major or local area network are recommended as the pathway for information flow. It is suggested that the major network approach has the advantages of using the existing network and expertise, good performance, and a higher level of reliability than casual telecommunication. Characteristics of local area networks include: multipoint interconnection of devices with a decentralized computing load, data and device sharing, and speed. (Author/SW)

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Personal Computer Communications

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Many universities need to use personal computer systems either as terminals or as distributed processing workstations. There is an ever growing demand for information to be transported from the "main computer" to a user site, or vice versa.

This paper will discuss the interconnection between personal computers and other personal, mini, or mainframe computer systems. Hardware techniques for tying computers together, a description of the software available and advantages and disadvantages will be presented.

In addition, we will take a look ahead to the emergence of sophisticated micro/mainframe links with major software systems and will discuss strategies for data sharing and the role of the Information Centre. A brief review of products we have tried and are using at McGill will be presented.

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A year ago, my department, McGill University Management Systems, adopted a support policy for personal computers (PC's). We standardized on the IBM PC, and encouraged administrative departments to use PC's. At that time there were only three personal computers in use for administrative applications. Today, that number has increased to 25 and is steadily increasing. Several of these users have requested that Management Systems provide them with a way to link their PC's to our large mainframe based systems.

Personal computer users want to communicate with other PC's, minicomputers, or mainframes to exchange information and messages with other users, and to share common data and devices. There are several ways to accomplish these objectives. A simple way to exchange information between users and systems is with paper. Some of our first PC users wanted to provide us with input to update programs from data entered on their PC's. For example, they might have the data in the form of a spreadsheet. A simple solution to the problem of getting this data into our system was to have the user print out the data in the form of a neat listing, and then our data entry group took over. This works very well for ad hoc requests, or small infrequent batches of data, especially if the data was previously provided on handwritten graph sheets!

Obviously, it is desirable to avoid the re-entry of data already in machine readable form, and to eliminate the possibility of data entry errors taking place. A second way to exchange information stored on a PC is via diskette. Diskettes are compact when compared to paper, and can be mailed. Two PC users can easily exchange data in this way. The MIS department could also accept diskettes, and transfer the stored information to its computer system over a communication link (more about this later). The problem with diskettes however, is handling and media compatibility. Diskettes are easily damaged by rough treatment and stray magnetism, and don't travel well unless carefully protected. In addition most personal computers cannot read diskettes created on a personal computer from another manufacturer. Like paper, diskettes must physically travel from one point to the next, and this can take time.

A better way for PC's to communicate with other computers is over wires. For casual telecommunication, the wires may belong to the telephone company. For more dedicated use, either a major network, or local area network can provide a path for the flow of information. The use of an electronic, wired communication scheme avoids the shortcomings of physical methods like paper or diskettes, such as handling or distance. In some cases electronic communication can solve the problems of incompatibility, and errors during transfer.

For casual communication between PC's or between PC's and larger computers, asynchronous (start-stop) telecommunication works well. This kind of communication is generally point to point (two computers linked to each other), and takes place over

public telephone lines or twisted pair wiring (a fancy name for wire like that used by the phone company). Signalling between devices is done using the common RS-232 interface standard, and except for very short distances, modems are used at both ends. Examples of this sort of communication would be a teletype terminal hardwired to an IBM mainframe, or a VT-100 terminal dialed to a VAX minicomputer over the telephone system.

Telecommunication is the first approach tried by PC users. The hardware requirements are a PC with RS-232 communications, and a modem. Most PC's are purchased with a RS-232 port (often on a combination card), and modems can be bought for very little or may already exist within the user's department. In order to be up and running, some software is needed to make the PC communicate. The software makes the PC act like a "dumb" or "smart" terminal, as this is what the other computer (host) expects. Examples of this kind of software are: Crosstalk XVI, PC-TALK, IBM Asynchronous Communication, etc. Literally dozens of these software packages exist. Important features to look out for are: ease of use, ability to emulate popular terminal types and file transfer (upload, download) capability. Other features include flexible parameter setting (so that you can customize), high speed (for local attachment), and automatic operation (automatic log-on, automatic answer). With automatic answer the PC can act as a host system to other PC's, or run a bulletin board service (BBS).

The main advantage of telecommunication is that it is easy to accommodate, and it is inexpensive. Most colleges and universities can easily adapt to this communication scheme, as it relies on existing telephone wiring, and commonly used modems. Although it works reasonably well, and distance is no barrier, the software can be tricky to use. There are many different host systems that all work a bit differently, and many kinds of hardware are involved. At first, the user tends to be confused about what options to select from the choices provided by the software packages. After the initial connection, things tend to work well as long as the user sticks to one host system, and the host system does not change procedures too often (log-on sequences, etc.). File transfers often prove to be especially frustrating, as they often rely on the user understanding the host system's editor, file conventions, and so on. Other disadvantages of telecommunications are weak error detection schemes, and the slow speed of communication. But in all fairness this method is fine for casual use.

Major dedicated networks support the interconnection of many devices (multipoint). These networks are usually mainframe oriented, with a central mainframe tied to a large periphery of terminals or remote job entry stations. Wiring is usually coaxial cable or twisted pairs. Either synchronous or bi-synchronous (BSC) data transmission is used (which are more complicated than asynchronous, and use timing "synchronization" for data decoding). Cluster controllers and synchronous modems are normally used to connect devices on the network. An example

of this kind of system would be an IBM mainframe supporting a network of 327x terminals, perhaps using SNA, or SDLC protocols (network software).

The second approach to communication usually involves the major networks. University campuses already have such networks already in place, serving both academic users and MIS. For this reason, the MIS department is usually attracted to linking PC's in this way, as the network and expertise are well established. Hardware required to allow PC's to hook into the network comes in the form of a special communications card to plug into the PC, such as the AST 3274 SNA card, or the TAC 3278 Irma card. The software required for terminal emulation is provided with the card, and allows the PC to be immediately inserted as a terminal into the network. Beyond this terminal emulation, (which has limited value), sophisticated software that integrates with the host software is required for file transfers or distributed processing. Recent examples of such software are beginning to emerge, with packages like: Tempus-Link, Omni-Link, PC Link and others from firms well known in the mainframe market - On-Line Software International, McCormack & Dodge, Informatics, Cullinet, Focus. These packages provide the user with transparent file transfer (virtual floppies), data provided in the form of popular packages such as Lotus 1-2-3, or links to large data base management systems.

The major network approach has the advantages of using the existing network and expertise, good performance, and a higher level of reliability than casual telecommunication. On the negative side, equipping each PC is more expensive than it is for asynchronous RS-232 communications, and it is not easy to justify placing a PC on the network if it cannot do more than a terminal can do. PC's are still considerably more expensive than 327x terminals when equipped with the communication card. To fully utilize the PC's potential, an integrated micro-mainframe link is required. These packages are very new, and are still being refined. At present they still represent a "kluge" approach.

Local area networks are a recent development. These networks provide for multipoint interconnection of devices. Usually the device is a personal computer, as local area networks (LAN's) are distributed data processing (DDP) oriented. DDP means that the computing load is decentralized (closely matching the flow of work), rather than centralized in location. The wiring is usually coaxial cables or twisted pairs as in major networks, but the layout of the wiring (topology) is usually different. Whereas major networks are usually wired like a star or a tree, LAN's are usually closed loops, or open-ended chains. They are called "local" because they usually do not involve more than two kilometres of cable, are are generally restricted to a single building or office complex. Some of the more popular networks are: PCnet, Omninet, Nestar and 3Com Ethernet. A good discussion of PC networks can be found in the November 1983 issue of PC magazine.

The local area networks provide a new way to communicate. In addition to information exchange, they permit data and device sharing, and are an excellent vehicle for DDP. Hardware requirements consist of a network interface card for each PC, and a network controller which could be one of the PC's in the network, or a specialized microcomputer. This controller, or server, may also be attached to expensive devices that other PC's in the network can share; hardware like hard disks or high speed printers are good examples. Software to run the network comes bundled with the network hardware, and may include features like "electronic mail" for user message exchange.

A primary advantage of the LAN is speed. The networks themselves can handle data rates of up to ten million bits per second (BPS). In practice however, such rates are not attainable with the memory and input-output speeds of current microprocessors and disks. The LAN creates an ideal atmosphere for distributed processing through data and device sharing, and their open-ended design allows for new PC's to be easily added to the network as the need arises. The major disadvantage of LAN's are their newness. It seems that almost every LAN in actual operation is a beta test site (the user gets the bugs out for the manufacturer), therefore these LAN's are not yet fully reliable. They are also fairly expensive, and each network is incompatible with the others (so what else is new?) The present level of software does not provide a true multi-user environment, and care must be exercised to prevent users from crashing the network or corrupting files. In spite of this, networks offer tremendous promise in the years ahead, and are well suited for use in the somewhat autonomous and localized nature of college and university administrative structures.

At McGill we have tried various means of getting our PC's to talk to other computers. Presently there are 25 PC's used for administrative purposes. For casual telecommunication we have tried the IBM asynchronous communications card, the AST ComboPlus card with on-board asynchronous communication, the IBM Asynchronous Communication program (versions 2.0 and lower), and Microstuf's Crosstalk XVI communication program. In both cases IBM lost out, we now equip all our PC's with the AST card, and use the Crosstalk package. The AST card offers memory and I/O, makes economic good sense, and takes only one slot. The crosstalk package does everything we expect it to do, is fairly easy to use, has good file transfer ability and is quite fast.

We have a network of 105 3270 type terminals which are used for our on-line systems (IMS, TSO and MUSIC). Into this network we attached a PC with an Irma card from TAC, and found it served as a satisfactory 3278 terminal. The software did not provide for any file transfers, but this is presently being rectified by TAC, and new software upgrades have been announced. Some BASIC program calls were provided for user-written file transfer routines, and we tried writing some of these, but the results were poor, as even a compiled BASIC program ran too slowly.

The only local area network we have tried is PCnet, with two machines. The documentation was rather poor, and the network did not work due to a conflict with hardware interrupts. A later release of PCnet provided the user with a means to select interrupts, and we tried this as well. This got PCnet working, but there were still some problems with sharing a printer and using BASIC. Part of this was the fault of BASIC, which tends to take shortcuts and bypasses the disk operating system. We are presently fence-sitting, and waiting for networks to mature. Our sister university in Montreal, Concordia, is using the Nestar network with 20 student PC's, and it is running well.

In addition to hardware on the micro end of things, we also have two protocol converters at the mainframe end. These allow remote users with terminals or PC's emulating terminals to dial in and emulate full-screen 3270 type terminals. This works, but remote access is slow, and the emulation and conversion add considerable overhead and complexity to the communication.

Our eventual goal is to get our administrative PC's communicating. Our users would like to access data stored on the mainframe, and use it on their micros. They would also like to transfer data from their PC to our mainframe. Providing this kind of service requires a data distribution strategy. The key issues here are: accuracy, security, and back-up of data. We are concerned about providing data to users that could quickly become out of date, or be misused or wiped out. In order to establish a strategy and a method, the creation of an Information Centre within the MIS department is appropriate. The Information Centre provides users with training, advice, and access to data on their own terms. The Information Centre staff works with the Data Base Administrator, and selects the appropriate software to get data to the users.

An example of such software is Tempus-Link from Micro Tempus Inc. in Montreal. Tempus-Link provides PC users with "virtual floppy disks" which are actually VSAM files on the mainframe. About 100,000 lines of code on the mainframe, and 2K of code on the PC are involved in this micro-mainframe package. The software also provides utilities to allow the MIS department to download files to PC's at night, keeping the PC files current and accurate. Once data is extracted from MIS files, it can be encrypted, so that it cannot be misused. Operating in reverse, it also allows the MIS department to upload PC user files at night to the mainframe for secure back-up.

A look ahead to the future, brings a vision of many improvements in PC communication. In October IBM announced the 3270 Personal Computer, and the XT/370. The thrust behind these new products is to tie together the various elements of computing and office automation, with the PC serving as the user workstation. Greater integration of micro and mainframe technologies should result. With major networks supporting PC workstations, and local area networks, DDP may become a reality at last! The public telephone companies are also entering the

fray with a switch to fully digital phone systems, and fibre optics. In Canada, Northern Telecom is researching a concept called the "Open World". This idea revolves around the use of the SL-1 telephone system to fully support digital data communication between every conceivable information device. Data transmission speeds of one million bits per second on ordinary phone wiring are operational in the lab. The future of PC's and computer communications is indeed a promising one.